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PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES #21

Applicant: **Kenichi Nanbu, et al.**	)	
	)	
Appln. No.: 09/233,073	)	Examiner: L. Vinh
	)	
Filed: January 19, 1999	)	Group Art Unit: 1765
	)	
For: METHOD OF ETCHING	)	

REQUEST FOR REINSTATEMENT OF APPEAL AND APPELLANTS' SUPPLEMENTAL BRIEF ON APPEAL

Respectfully submitted,

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REQUEST FOR REINSTATEMENT OF APPEAL AND APPELLANTS' SUPPLEMENTAL BRIEF ON APPEAL

REQUEST FOR REINSTATEMENT OF APPEAL

In response to the Office Action of April 11, 2001 in which prosecution in the above-referenced patent application was reopened, Appellants respectfully request, in accordance with 37 C.F.R. § 1.193(b)(2)(ii), reinstatement of the Appeal filed in the application on December 13, 2000 which was pending at the time the Office Action issued. Appellants file herewith, in triplicate, an Appellants' Supplemental Brief on Appeal, in accordance with 37 C.F.R. § 1.193(b)(2)(ii), in response to the Office Action of April 11, 2001. For the reasons which follow, Appellants respectfully request that the rejections of the Examiner be reversed, and the application allowed.

APPELLANTS' SUPPLEMENTAL BRIEF ON APPEAL

This Supplemental Brief on Appeal, filed in accordance with 37 C.F.R. §1.193(b)(2)(ii), is intended to address the Office Action of April 11, 2001 in which the Examiner reopened prosecution, and is intended to replace the Appellants' Brief on Appeal filed in the application on February 12, 2001, which resulted in prosecution being reopened by the Examiner.

I. THE REAL PARTY IN INTEREST

The Assignees of this patent application, Kenichi Nanbu (also one of the inventors, 50% interest) and Tokyo Electron Limited (50% interest), are the real parties in interest (Assignment recorded in the U.S. PTO on April 20, 1999 at Reel 009891, beginning at frame 0890). Kenichi Nanbu is a Japanese citizen who resides at 2-347, Takamori 4-chome, Izumi-ku, Sendai-shi,

Miyagi-ken, Japan, and Tokyo Electron Limited is a corporation of Japan having a place of business at 3-6, Akasaka 5-chome, Minato-ku, Tokyo-to, Japan.

II. RELATED APPEALS AND INTERFERENCES

To the best of the undersigned's knowledge, no other appeals or interferences will directly affect, will be directly affected by, or will have a bearing on the Board's Decision in this appeal.

III. STATUS OF THE CLAIMS

Claims 1-14 are pending in this application and constitute the claims on appeal. These claims are reproduced in Appendix A attached to this Brief, as required by 37 C.F.R. § 1.192(c)(9).

IV. STATUS OF AMENDMENTS

Appellants filed an Amendment After Final on July 24, 2000. In an Advisory Action dated August 1, 2000 (Paper No. 12), the Examiner advised that this Amendment would be entered upon filing a Notice of Appeal and an Appeal Brief. Accordingly, Appellants understand that the July 24, 2000, Amendment is <u>entered</u>.

V. SUMMARY OF THE INVENTION

Solid state electronic devices are essential to a vast array of products, processes, and services in use today in the United States and throughout the world. The growing demand for

such devices is coupled with increasingly stringent specifications requiring that the devices produced be smaller, faster, and cheaper.

This invention relates to an etching process used in production of semiconductor devices. Generally, in forming semiconductor devices, film forming processes are used for forming various films and layers on semiconductor wafers or glass substrates. These films or layers often are etched to form a desired pattern necessary for various devices, such as semiconductor integrated circuits or LCD panels. See Appellants' specification at page 1, lines 8-12.

When forming, for example, a MOSFET (Metal Oxide Semiconductor Field Effect Transistor), a polysilicon film etching process typically is carried out to form the gate electrode of the transistor. This etching process is very important because the length of the gate electrode of the MOSFET is an important factor in determining the electric characteristics of the device. Therefore, the polysilicon film must be etched over the entire surface of the supporting wafer to form the gate electrode having a precise length. This gate forming process requires highly accurate and uniform processing. Id. at page 1, lines 13-20.

In many instances, the gate electrode for a MOSFET is produced by etching, using an inductive coupled plasma processing system that operates at a low pressure.[1] A conventional inductively coupled plasma processing system is described and illustrated in conjunction with Fig. 9 of Appellants' application (Id. at page 1, line 28 through page 2, line 22). When a

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Generally, the process pressures used in conventional diode parallel-plate plasma etching systems are excessively high, and such systems are unable to etch the polysilicon film surface with sufficient uniformity. See Appellants' specification at page 1, lines 21-27.

semiconductor wafer film is etched using such a system, however, typically there is a considerable difference between the etch rate at the peripheral part of the wafer and the etch rate at the central part of the wafer, which results in a non-uniform etch. This non-uniformity becomes particularly problematic when etching large wafers (*e.g.*, 12 inch (30 cm) wafers). Id. at page 2, lines 23-31.

Appellants' invention addresses this non-uniformity problem and provides an etching method capable of etching a film at a greatly improved, uniform etch rate. Id. at page 2, lines 34-37. The etching method according to Appellants' invention includes: (a) supplying an etching gas into a plasma producing chamber; (b) producing a plasma in the chamber by applying radio frequency power to the etching gas which thereby produces radicals from the etching gas; and (c) etching an object to be processed in an evacuated reaction chamber, which is connected to the plasma producing chamber, by the radicals flowing from the plasma producing chamber into the reaction chamber. In the claimed process, the etching gas is supplied at a supply rate of 8.4 sccm ("standard cubic centimeters per minute") or above per liter of the reaction chamber. Id. at page 3, lines 9-20. When the etching gas is supplied at the claimed supply rate, the uniformity of etching over the surface of the object, as well as the etch rate, are improved. Id. at page 3, lines 21-24.

VI. ISSUES

The following issues are presented for consideration in this appeal, in view of the Office Action of April 11, 2001:

(A) Did the Examiner commit reversible legal error in rejecting claims 1-6 and 11-13 under 35 U.S.C. § 103(a) based on the combination of Collins et al. in view of Szwejkowski et al.?

(B) Did the Examiner commit reversible legal error in rejecting claims 7, 8 and 14 under 35 U.S.C. § 103(a) based on the combination of Collins et al in view of Szwejkowski et al., and further in view of van Os et al., U.S. Pat. No. 5,792,272 (hereinafter "van Os et al.")?

(C) Did the Examiner commit reversible legal error in rejecting claims 9 and 10 under 35 U.S.C. § 103(a) based on the combination of Collins et al. in view of Szwejkowski et al., and further in view of van Os et al.?

VII. GROUPING OF CLAIMS

Claims 1-14 are pending in this application and constitute the claims on appeal. For consideration on appeal, these claims are grouped as follows:

(A) Claims 1-6 and 11-13, describing an etching method, stand and fall together;

(B) Claims 7, 8 and 14, reciting a flow of etchant provided at a flow rate which produces a flow diverging position with respect to an outer periphery of an object being etched that is substantially at or internal to the outer periphery of the object being etched, are believed to be separately patentable from claims 1-6 and 11-13 in this application, and do not stand or fall with the other claims

(separate arguments relating to the patentability of claims 7, 8 and 14 are presented in Section VIII, *infra*);

(C) Claims 7, 8 and 14 stand and fall together;

(D) Claims 9 and 10, reciting a flow of etchant provided at a flow rate which produces a flow diverging position that is internal to an outer periphery of an object being etched, are believed to be separately patentable from the foregoing claims in this application, and do not stand or fall with the other claims (a separate argument relating to the patentability of claims 9 and 10 is presented in Section VIII, *infra*); and

(E) Claims 9 and 10 stand and fall together.

VIII. ARGUMENT

In the Office Action of April 11, 2001, the Examiner rejected claims 1-6 and 11-13 under 35 U.S.C. § 103(a) as being *prima facie* obvious based on Collins et al. in view of Szwejkowski et al. The Examiner further rejected claims 7-10 and 14 under 35 U.S.C. § 103(a) as *prima facie* obvious based on Collins et al. in view of Szwejkowski et al. and van Os et al. For the reasons that follow, Appellants respectfully submit that these rejections constitute reversible legal error and request that this Board reverse the final rejection.

A. Claim 1 And Its Associated Dependent Claims Are Not Rendered *Prima Facie* Obvious By Collins And Szwejkowski

ISSUE (A): Did the Examiner commit reversible legal error in rejecting claims 1-6 and 11-13 under 35 U.S.C. § 103(a) based on the combination of Collins et al. in view of Szwejkowski et al.?[2]

ANSWER: Yes, for the reasons described below.

1. General Background Information Relating to this Issue

Appellants' claim 1 relates to an etching method that includes the steps of: (a) supplying an etching gas from a gas supply system into a plasma producing chamber; (b) producing a plasma in the plasma producing chamber by applying radio frequency power to the etching gas to thereby produce radicals; and (c) etching an object to be processed in an evacuated reaction chamber that is connected to the plasma producing chamber by the radicals flowing from the plasma producing chamber into the reaction chamber. Claim 1 further provides that the etching gas is supplied at an etching gas supply rate of 8.4 sccm or above per liter of the reaction chamber.

In the Office Action dated April 11, 2001, the Examiner rejected claims 1-6 and 11-13 as being unpatentable (as obvious) over the combination of Collins et al. in view Szwejkowski et al. In making this rejection, the Examiner admitted that:

> Collins differs from the instant claimed invention as per claim 1 by supplying etching gas of Chlorine at a flow rate of 50 cc instead of an etching gas supply rate of 8.4 sccm or above for a substantial volume of one liter of the processing chamber as claimed in the instant invention.

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Because claims 2-3 and 11-12 stand and fall together with their ultimate parent claim, claim 1, the following arguments focus on the content of claim 1. These patentability arguments, however, apply with equal force to all of the claims that depend from claim 1.

See the April 11, 2001 Office Action at page 3, lines 16-18. Appellants agree with the Examiner's finding that Collins et al. do *not* disclose the etching gas supply rate range recited in claim 1 of this patent application.

In an effort to address this admitted deficiency in the Collins et al. patent, the Examiner relied upon Szwejkowski et al. According to the Office Action of April 11, 2001:

> Szwejkowski discloses a process for the RIE etching [reactive ion etching] [of] a polysilicon film on a silicon wafer in a vacuum etch chamber using Chlorine etching gas at a rate of from about 40 to about 100 sccm into a 3 liter vacuum processing chamber (40 sccm/3 liter = 13.3 sccm/liter within the range of 8.4 sccm to 16.9 sccm for a substantially volume of one liter) (Col 4, lines 19-22). Szwejkowski also discloses that the pressure inside the vacuum chamber may range from about 10 mTorr - 100 mTorr (Col. 3, lines 33-34)

See the April 11, 2001 Office Action at page 3, line 17 to page 4, line 4. From these teachings in Szwejkowski et al., the Examiner alleged that it would have been obvious to one of ordinary skill in the art to use the flow rate for the etching gas in the Szwejkowski et al. "RIE" system (about 13.3 sccm/l) in the process of Collins et al. because:

> Szwejkowski states that using the gaseous component and flow rate of his invention will not result in the undesirable formation of particles on the wafer surface and will not condense at room temperature in the lines used to bring the etchant gases to the vacuum etch chamber (Col 5, lines 49-54).

See the Office Action of April 11, 2001, at page 4, lines 5-9. Appellants respectfully submit that the Examiner has failed to carry his burden of demonstrating that the claims are *prima facie* obvious.

2. The Examiner Misconstrued the Teachings of Szwejkowski et al. in an Effort to Find "Motivation" for Combining the Flow Rate of Szwejkowski et al. with the System of Collins et al.

As just described, the asserted "motivation" for combining the teachings of Szwejkowski et al. with Collins et al. was given as follows:

> Szwejkowski states that using the gaseous component *and flow rate* of his invention will not result in the undesirable formation of particles on the wafer surface and will not condense at room temperature in the lines used to bring the etchant gases to the vacuum etch chamber (Col 5, lines 49-54) (Emphasis added).

See the Office Action of April 11, 2001, page 4, lines 5-9 (Emphasis added). Appellants respectfully submit that the cited statement misstates the teachings of Szwejkowski.

The cited portion of Szwejkowski reads as follows:

> Thus, the invention provides an improved tungsten silicide etch process wherein both tungsten silicide and polysilicon may be etched in an etch process having a high selectivity to both photoresist and oxide, using gaseous components of the etch available in high purity form, which will not result in the undesirable formation of particles on the wafer surface and which will not condense at room temperature in the lines used to bring the etchant gases to the vacuum etch chamber.

See Szwejkowski et al. at column 5, lines 46-54. As evident from these teachings in Szwejkowski et al., the stated avoidance of particle formation and condensation are *not* positive effects gained from a specified etchant gas flow rate. The cited passage in Szwejkowski et al. makes no mention of an advantageous etchant gas flow rate. Rather, the cited advantages are a result of using high purity etch gas. This is even more apparent when one considers the discussion in Szwejkowski et al. of the problems encountered when using BCl_3 gas from the prior art (see, for example, Szwejkowski et al. at column 1, lines 39-44). Contrary to the Examiner's assertions, nothing in Szwejkowski et al. correlates avoidance of undesirable particle and condensation formation with selection of a specific etchant gas flow rate.

Therefore, at most, Szwejkowski et al. may have induced the skilled artisan to select a high purity etchant gas in the Collins et al. system in an effort to avoid undesirable particle and condensation formation. Nothing in Szwejkowski et al., however, teaches or suggests that appropriate selection of the etchant gas flow rate can assist in creating these advantages. Accordingly, the Examiner's cited "motivation" for combining the flow rate of Szwejkowski et al. with Collins et al. misconstrues Szwejkowski et al.'s teachings. Thus, there is no motivation, teaching, or suggestion for combining the flow rate of Szwejkowski et al. with the system of Collins et al.

3. Because the Methods and Systems of Collins et al. and Szwejkowski et al. Are So Different from One Another, a Person of Ordinary Skill in the Art Would Not Have Been Motivated to Combine Their Teachings in the Manner Suggested by the Examiner

Appellants further assert that a person of ordinary skill in the art would not have been motivated to use the flow rate described in Szwejkowski et al. in the system according to Collins et al. This is because the systems of Collins et al. and Szwejkowski et al. operate quite differently from one another. Relying solely on hindsight and using Appellants' specification and claims as a guide, the Examiner selectively combined the teachings of these references in an effort to arrive at Appellants' claimed invention. Because a person of ordinary skill in the art would not have been motivated to make this selective combination, there is no *prima facie* case of obviousness against claim 1 and its associated dependent claims. This rejection should therefore be reversed.

Columns 6-7 of Collins et al. provide a general overview of the Collins et al. system. The Collins et al. system is a plasma reactor chamber system 10 for processing a semiconductor wafer 5 which uses an inductive plasma source arrangement, a capacitively coupled bias arrangement, and preferably a magnetic plasma source confinement arrangement. In Collins et al., the plasma is generated in plasma chamber 16A, located in the dome 17, through use of radio frequency ("RF") energy supplied by antenna 30 wrapped around the dome 17. <u>See</u> also Collins et al., Figs. 1-3.

In Collins et al., the wafer support structure 32 includes a portion that acts as a cathode 32C. As described at column 4, lines 27-32 in Collins, the wafer cathode support arrangement is used for effecting control of the cathode sheath voltage and ion energy, independent of the plasma density control effected by the high frequency power. Accordingly, Collins et al. describe a reactor which features <u>an inductively coupled plasma generating system</u> with an independent, additional capacitive control system.

Notably, in the system described by Collins et al., the wafer support cathode 32C is **<u>not</u>** used as an electrode for generating the plasma. Quite to the contrary, Collins et al. expressly *distinguish* their inductively coupled plasma generating system, in which the wafer support is independently used for effecting control of the cathode sheath voltage and ion energy, from "conventional arrangements" that use the wafer support as a cathode for generating the plasma. Specifically, Collins et al. explain:

> This [system] contrasts with conventional RF system arrangements, in which the RF power is applied between two electrodes, typically the wafer support electrode 32C, the upper surface of which supports wafer 5, and a second electrode which is the sidewalls 12, top wall 13 and/or manifold 23 of the reactor chamber.

See Collins et al. at column 8, lines 44-49. Thus, Collins et al. clearly distinguish their inductively coupled plasma generating system from those using a wafer support electrode for generating the plasma.

The system described in Szwejkowski et al. is the type of system which is distinguished by Collins et al. Specifically, Szwejkowski et al. describe their plasma generating apparatus as follows:

> The wafer to be etched is conventionally mounted in the vacuum chamber on a cathode support which is connected to the negative terminal of a grounded power supply. During the etch, a plasma is ignited between the cathode and the grounded walls of the chamber and the grounded showerhead [emphasis supplied].

See Szwejkowski et al. at column 3, lines 36-41.

Because Collins et al. expressly distinguish their system from the type described by Szwejkowski et al, Appellants respectfully submit that a person of ordinary skill in the art would not have been motivated to combine the teachings of Collins et al. and Szwejkowski et al. in the manner in which the Examiner has combined them. Rather, Collins et al. expressly teach away from the combination relied upon by the Examiner in the Office Action. For this reason, Appellants respectfully submit that Collins et al. and Szwejkowski et al. have been improperly combined to reject claim 1 of this application.

The differences just described between the systems of Collins et al. and Szwejkowski et al. also translate into quite practical reasons why a person of ordinary skill in the art would not have been motivated to use the etching gas flow rate of Szwejkowski et al. in the system of Collins et al. Because the plasmas of the two teachings are generated at different locations, and

in different manners, the etchant gas would be exposed to substantially different flow conditions and flow characteristics in these two systems. Nothing in either Collins et al. or Szwejkowski et al. indicates that a higher etchant gas flow rate might be used in the system of Collins et al.

Also, Appellants respectfully advise that different etching gas flow rates traditionally have been used, depending on the type of reactive ion etching system used. Conventional inductively coupled plasma processing systems, such as those described by Collins et al. and that described in the present application and depicted in Fig. 9, operate at a low process pressure and rely upon production of a high density plasma cloud and diffusion spread of the radicals in the low pressure environment so that the radicals fall substantially uniformly on the surface of the wafer being etched. Thus, under this type of a conventional system, an etching gas flow rate of about 125 sccm per 59 liters (or 2.1 sccm/liter) for chlorine previously has been used to achieve the desired diffusion spread and etching results. See, for example, Appellants' specification at page 1, line 28 through page 2, line 31, and particularly, page 2, lines 9-22.

On the other hand, in reactive ion etching systems featuring a wafer support that acts as a cathode for plasma generation, such as that described by Szwejkowski et al., the charged cathode produces an ion pulling effect that attracts ions formed in the etching gas toward the cathode. Thus, higher etching gas flow rates typically are used in such systems to prevent the gas from concentrating at the center of the wafer and producing a non-uniform etch. Again, nothing in either Collins et al. or Szwejkowski et al. teaches or suggests that the higher etching gas flow rate of Szwejkowski et al. should be used in the system according to Collins et al.

Applicants therefore respectfully submit that the evidence of record demonstrates that the inductively coupled plasma generating system of Collins et al. differs significantly in

operation from the system of Szwejkowski et al., which utilizes the wafer support as the cathode for plasma generation. The Collins-type systems use low etching gas flow rates to allow the etching gas to diffuse over the entire surface of the wafer. The Szwejkowski-type systems use higher etching gas flow rates because the charged wafer support (*i.e.*, the cathode) would otherwise concentrate too much etching gas at the center of the wafer, thereby producing a non-uniform etch. There is no motivation, teaching, or suggestion in Szwejkowski et al. that the relatively high etching gas flow rate in this system might be useful in the much different, diffusion based system of Collins et al. Nor is there any motivation, teaching or suggestion in Collins et al. that a flow rate such as that taught in Szwejkowski et al. might be useful in the system according to Collins et al. Only Appellants' specification and claims provide the motivation or suggestion for applying Szwejkowskiet al.'s flow rate to the system of Collins et al. Thus, Appellants submit that the rejection improperly relies on hindsight and Appellants' disclosure and therefore fails to set out a *prima facie* case of obviousness.

4. There Is No Reasonable Expectation That the Flow Rate of Szwejkowski et al. Could Be Used Successfully in the System of Collins et al.

To establish *prima facie* obviousness by combining the teachings of two or more references, there must be some reasonable expectation that the combination would function successfully. <u>See</u> *In re Merck & Co., Inc.*, 800 F2d 1091, 231 USPQ 375 (Fed. Cir. 1986), cited in *The Manual of Patent Examining Procedure* ("*M.P.E.P.*") § 2143.02.

The systems of Collins et al. and Szwejkowski et al. operate quite differently in the manner in which the plasma is generated, the location at which the plasma is generated, and the

manner in which the etching gas reaches the wafer surface (*i.e.*, diffusion v. electrical attraction forces). Thus, a person of ordinary skill in the art would not expect that process conditions useful in Szwejkowskiet al.'s system could automatically be transferred to the much different Collins et al. system. Additionally, nothing in either Collins et al. or Szwejkowski et al. teaches or suggests that the system of Collins etal. could be expected to work successfully with an increased etchant gas flow rate as described by Szwejkowski et al. Again, only Appellants' specification and claims bridge the gap in the teachings of Collins et al. and Szwejkowski et al. However, the Examiner is not permitted to rely upon hindsight and the Appellants' specification and claims to find the motivation for combining references. Thus, *prima facie* obviousness has clearly not been established.

Appellants respectfully note that the legal standard to be applied by U.S. PTO Examiners for determining whether *prima facie* obviousness has been established is set out in *M.P.E.P.* § 2143.01 as follows:

> Obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion or motivation to do so found either in the references themselves or in the knowledge generally available to one of ordinary skill in the art. *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988); *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992).

As further set out in *M.P.E.P.* § 2143.01, "[t]he mere fact that references <u>can</u> be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination. *In re Mills*, 916 F.2d 680, 16 USPQ2d 1430 (Fed. Cir. 1990) [emphasis in original]."

The general presence of some common elements in the teachings of Collins et al. and Szwejkowski et al. does not itself provide the required suggestion or motivation to alter the flow rate of Collins et al. with that described in Szwejkowski et al. This is particularly true when, as here, the references describe quite different systems and methods.

The fact that both Collins et al. and Szwejkowski et al. generally involve reactive ion etching ("RIE") systems (argument "1" above) does not, by itself, indicate to one of ordinary skill in the art that any process condition used by Szwejkowski et al. can be transferred to the system of Collins et al. As described above, these systems are very different from one another. For example, Szwejkowski et al. ignite a plasma between the support cathode and the grounded walls of the chamber and the grounded showerhead. The plasma location and generation in Szwejkowski et al. is therefore quite different from that of Collins et al., who generate a plasma in plasma chamber 16A located in a dome 17 surrounded by an antenna 30. Because the plasma location, generation, and maintenance in Collins et al. and Szwejkowski et al. are quite different, a person of ordinary skill in the art would not expect that the etchant gas flow rate of Szwejkowski et al. could be transferred into the system of Collins et al. Thus, the mere fact that both Collins et al. and Szwejkowski et al. are generally directed to RIE etching techniques does not provide one of ordinary skill in the art with a suggestion or motivation for using Szwejkowski et al.'s etchant gas flow rate in the system of Collins et al.

5. Conclusion Regarding the Obviousness Rejection of Claim 1 and its Associated Dependent Claims

For the reasons just described, Appellants respectfully submit that Collins et al. and Szwejkowski are not properly combined to reject Appellants' claims 1-6 and 11-13. Because the systems of Collins et al. and Szwejkowski et al. are quite different, one of ordinary skill in the art would not have been motivated to select the etchant gas flow rate of Szwejkowski et al. and use it in the system of Collins et al. Also, because of the significant differences between these systems, there is no reasonable expectation that the system of Collins et al. would operate successfully if such a change were made. Moreover, the Examiner has provided no reason as to why a person of ordinary skill in the art would have been motivated to change the etchant gas flow rate in Collins et al's system with that used by Szwejkowski et al.

Accordingly, the Examiner has failed to carry his burden of establishing that Appellants' invention, as defined in claim 1, is *prima facie* obvious. Therefore, Appellants submit that the rejection of claims 1-6 and 11-13 should be reversed.

B. Claims 7, 8 and 14 Are Not Rendered *Prima Facie* Obvious By Collins et al., Szwejkowski et al., and van Os et al.

ISSUE (B): Did the Examiner commit reversible legal error in rejecting claims 7, 8 and 14 under 35 U.S.C. § 103(a) based on the combination of Collins et al. in view of Szwejkowski et al., and further in view of van Os et al?

ANSWER: Yes, for the reasons described below.

1. General Background Information Relating to Claims 7, 8 and 14, and Their Rejection under 35 U.S.C. § 103(a)

Claims 7, 8 and 14 ultimately depend from claim 1, and the Examiner's rejection of these claims is believed to be erroneous for the reasons described above with respect to claim 1. These reasons are incorporated herein by reference. Additional arguments with regard to the separate patentability of claims 7, 8 and 14 follow.

In addition to the features of their parent claims, claims 7, 8 and 14 recite that the etchant gas is provided at a flow rate which produces a *flow diverging position* with respect to an outer periphery of an object being etched that is *substantially at or internal to an outer periphery of the object being etched.* This feature of Appellants' invention is depicted in Figs. 7A and 7B.

As described in the paragraph bridging pages 9 and 10 of Appellants' specification, when the etchant gas supply rate is higher (as recited in Appellants' claims), the diverging position of the flow is located *at or inside* the object being treated. When the etchant gas flow rate is lower, as shown in Figs. 8A and 8B, the diverging position moves *outside the object being treated.* A diverging position outside the object being treated produces a strong flow of etching gas toward the central part of the wafer, and increases the etch rate at the peripheral part of the wafer. Therefore, the increase in the etch rate at the peripheral part of the wafer can be suppressed according to the invention, when the etching gas supply rate is high and the diverging position is moved inward. This improves the uniformity of the etch rate over the surface of the object being treated. <u>See</u> Appellants' specification at page 9, line 27 through page 10, line 10.

In the Office Action of April 11, 2001, the Examiner admitted that neither Collins et al. nor Szwejkowski et al. disclose this feature of Appellants' claimed invention. See the April 11, 2001 Office Action at page 4, lines 13-16. Appellants fully agree.

In an effort to address this admitted deficiency, the Examiner relied upon van Os et al. Specifically, the Examiner stated:

> van Os discloses a plasma etching method, which uses an inductively coupled plasma chamber at low pressure, compris[ing] the step of flowing etchant (CF_4) into the process chamber to produce [a] flow diverging position at [an] internal location to the outer periphery of the wafer (col 4, lines 3-20[)], fig. 6 shows etchant flow pattern diverges at [a] position[] that is internal to the outer periphery of wafer 24[,] read[ing] on a flow of etchant [] provided at a flow rate which produces a flow diverging position that it substantially at or internal to the outer periphery of an object (wafer) being etched.

It was concluded based on these assertions that one skilled in the art would have found it obvious to modify the teachings of Collins et al. and Szwejkowski et al. to produce a flow diverging position with respect to the outer periphery of the wafer as per van Os et al, in order to achieve uniform concentration of etchant and to promote uniform etching across the wafer. Appellants respectfully submit that both the claimed invention and the teachings of van Os et al. have been misconstrued, and that the cited motivation can only be found in the Appellants' disclosure.

2. The Examiner Misconstrued the Teachings of the Claimed Invention, and the Teachings of van Os et al., in an Effort to Find "Motivation" for the Flow Diverging Position according to the Claimed Invention

The Appellants' specification explains, in the paragraph bridging pages 9 and 10, that when the etchant gas supply rate is within the range recited in Appellants' claims, the *diverging position* of the flow is located *at or inside* the object being treated. This feature of Appellants' invention is depicted in Figs. 7A and 7B, in which the claimed flow diverging position is indicated in each instance with an arrow. Fig. 7A depicts a flow rate of 1000 sccm, and Fig. 7B depicts a flow rate of 500 sccm. In contrast, when the etchant gas flow rate is *below* the claimed range, as shown in Figs. 8A and 8B, the diverging position moves *outside the object being treated.* Fig. 8A depicts a flow rate of 250 sccm, and Fig. 8B depicts a flow rate of 125 sccm being utilized such that there is produced a flow diverging position relative to the object being treated which does not satisfy the requirement in the claims that the diverging position of the flow be located *at or inside* the object being treated.

The Appellants have determined that a diverging position *outside* the object being treated produces a strong flow of etching gas toward the central part of the wafer, and increases the etch rate at the peripheral part of the wafer. This results in uneven etching of the periphery with respect to the central part of the wafer, and is disadvantageous. The Appellants have also determined that the higher flow rate according to the invention facilitates this problem in the art. See Figs. 3-6 of the specification, and the text explaining the results depicted in Figs. 3-6 at page 7, line 7 to page 9, line 26. Therefore, the increased etch rate at the periphery of the wafer can be suppressed, according to the invention, with a gas supply rate which is *higher* than that conventionally used, which provides a flow diverging position that is moved *inward* with respect to a conventional flow diverging position. This improves the uniformity of the etch rate over the surface of the object being treated. See Appellants' specification at page 9, line 27

through page 10, line 10. This advantage is neither disclosed nor fairly suggested by van Os et al.

Contrary to the claimed invention, in which a higher flow rate produces a flow diverging position located *at or inside* the object being treated, van Os et al. neither disclose nor fairly suggest that the flow rate of the gas might have any effect whatsoever on a flow diverging position. Indeed, van Os et al. make no mention whatever of a flow diverging position, nor how such a position might be obtained or manipulated, nor what might be the result.

Rather than teaching that the flow rate may be set to achieve an advantageous flow diverging position relative to the object being treated. Van Os et al. instead teach only that the gas used be provided from two separate gas manifolds with one gas flow designed to impact the other. It can be seen from Fig. 6, cited by the Examiner, that van Os et al. teach both a first gas manifold 15, and a second gas manifold 17, provided at different positions above the object to be processed 24. The flow lines depicted are merely produced by the combination of the gas flows from the first and second injection manifolds 15 and 17. In the claimed invention, in contrast, it is the flow rate of a flow of gas that determines the flow divergent position relative to the object being treated. It is therefore respectfully submitted that van Os et al. do not depict in Fig. 6, nor do they describe in the accompanying text, a flow diverging position produced by a flow rate of a flow etchant. Appellants respectfully note that the Examiner has *not* given any indication in the Office Action where the asserted flow diverging position might be. Nor does van Os et al. indicate such a position. Indeed, only the Appellant's specification teaches such a position. Nor do van Os et al. describe how such a flow diverging position might be obtained,

nor how it might be advantageously manipulated. Appellants respectfully submit that van Os et al. is entirely silent concerning a flow diverging position.

3. The Motivation cited by the Examiner has been Improperly Derived from the Appellants' Own Specification

The Examiner, in rejecting claims 7-10 and 14, asserted that one skilled in the art would have found it obvious to modify Collins et al. and Swejkowski et al., by providing a flow rate of etchant to produce a flow diverging position with respect to the outer periphery of the wafer, as assertedly taught in van Os et al., in order to achieve a uniform concentration of etchant, and to promote uniform etching across the wafer. Appellants respectfully submit that the cited motivation could only be derived from the Appellant's own specification, and that the rejection is therefore improper.

Appellants respectfully submit that only the present specification teaches or fairly suggests providing a flow rate of etchant to produce a flow diverging position. The references cited in support of such motivation have already been distinguished on the basis that they lack any such teaching. Similarly, only the Appellants' specification teaches or suggests producing a flow diverging position located *at or inside* the object being treated in order to achieve a uniform concentration of etchant and to promote uniform etching across the wafer. Appellants have already demonstrated as well that the cited references neither teach nor suggest that the flow rate might be chosen to obtain an advantageous flow diverging position, and that this might in turn achieve a uniform concentration of etchant and promote uniform etching across

the wafer. Appellants therefore respectfully submit that the Appellants' own specification has been used as motivation, and that such use of the Appellants' specification is improper.

3. Conclusion Regarding the Obviousness Rejection of Claims 7, 8 and 14

Appellants respectfully submit that nothing in van Os et al. discloses or suggests that a flow diverging position be obtained, nor that such a position be located substantially at or internal to the outer periphery of the object being etched, as recited in Appellants' claims 7, 8 and 14. Appellants respectfully submit further that nothing in the other cited references discloses or suggests this feature of Appellants' claims. Appellants therefore respectfully submit that claims 7, 8 and 14 are not rendered *prima facie* obvious by the combination of Collins et al, Szwejkowski et al. , and van Os et al. Reversal of this rejection is therefore earnestly solicited.

C. Claims 9 and 10 Are Not Rendered *Prima Facie* Obvious By Collins, Szwejkowski, And van Os et al.

ISSUE (C): Did the Examiner commit reversible legal error in rejecting claims 9 and 10 under 35 U.S.C. § 103(a) based on the combination of Collins et al. in view of Szwejkowski et al., and further in view of van Os et al.?

ANSWER: Yes, for the reasons described below.

1. General Background Information Relating to Claims 9 and 10, and Their Rejection under 35 U.S.C. § 103(a)

Claims 9 and 10 ultimately depend from claim 1, and the Examiner's rejection of these claims is believed to be erroneous for the reasons described above with respect to claim 1. These reasons are incorporated herein by reference. Additional arguments regarding the separate patentability of claims 9 and 10 follow.

In addition to the features of their parent claims, claims 9 and 10 recite that the etchant gas is provided at a flow rate which produces a flow diverging position that is internal to an outer periphery of the object being etched. This feature of Appellants' invention is best illustrated in Figs. 7A and 7B. As described in the paragraph bridging pages 9 and 10 of Appellants' specification, when the etchant gas supply rate is higher (as recited in Appellants' claims), the diverging position of the flow is located internal to an outer periphery of the object being etched. When the etchant gas flow rate is lower than that of the claimed invention, as shown in Figs. 8A and 8B, the flow diverging position moves outside the object being treated. Such an outside flow diverging position produces a strong flow of etching gas toward the central part of the wafer and increases the etch rate at the peripheral part of the wafer. Therefore, an increase in the etch rate at the peripheral part of the wafer can be suppressed when the etching gas supply rate is high and the flow diverging position is moved inward relative to the object being treated. This improves uniformity of the etch rate over the surface of the object being treated. <u>See</u> Appellants' specification at page 9, line 27 through page 10, line 10.

In the Office Action of April 11, 2001, the Examiner admitted that neither Collins nor Szwejkowski discloses this feature of Appellants' claimed invention. Appellants fully agree.

In an effort to address this admitted deficiency, the Examiner relied upon van Os et al. Specifically, the Examiner stated:

> van Os discloses a plasma etching method, which uses an inductively coupled plasma chamber at low pressure, compris[ing] the step of flowing etchant (CF_4) into the process chamber to produce [a] flow diverging position at [an] internal location to the outer periphery of the wafer (col 4, lines 3-20[)], fig. 6 shows etchant flow pattern <u>diverges</u> at [a] position[] that is internal to the outer periphery of wafer 24[,] read[ing] on a flow of etchant [] provided at a flow rate which produces a flow diverging position that it substantially at or internal to the outer periphery of an object (wafer) being etched.

It was concluded based on these assertions that one skilled in the art would have found it obvious to modify the teachings of Collins et al. and Szwejkowski et al. to produce a flow diverging position with respect to the outer periphery of the wafer as per van Os et al, in order to achieve uniform concentration of etchant and to promote uniform etching across the wafer. Appellants respectfully submit that both the claimed invention and the teachings of van Os et al. have been misconstrued, and that the cited motivation can only be found in the Appellants' disclosure.

2. The Examiner Misconstrued the Teachings of the Claimed Invention, and the Teachings of van Os et al., in an Effort to Find "Motivation" for the Flow Diverging Position according to the Claimed Invention

The Appellants' specification explains, in the paragraph bridging pages 9 and 10, that when the etchant gas supply rate is within the range recited in Appellants' claims, the *diverging position* of the flow is located *at or inside* the object being treated. This feature of Appellants' invention is depicted in Figs. 7A and 7B, in which the claimed flow diverging position is

indicated in each instance with an arrow. Fig. 7A depicts a flow rate of 1000 sccm, and Fig. 7B depicts a flow rate of 500 sccm. In contrast, when the etchant gas flow rate is *below* the claimed range, as shown in Figs. 8A and 8B, the diverging position moves *outside the object being treated*. Fig. 8A depicts a flow rate of 250 sccm, and Fig. 8B depicts a flow rate of 125 sccm being utilized such that there is produced a flow diverging position relative to the object being treated which does not satisfy the requirement of claims 9-10 that the diverging position of the flow be located internal to an outer periphery of the object being etched.

The Appellants have determined that a diverging position *outside* the object being treated produces a strong flow of etching gas toward the central part of the wafer, and increases the etch rate at the peripheral part of the wafer. This results in uneven etching of the periphery with respect to the central part of the wafer, and is disadvantageous. The Appellants have also determined that the higher flow rate according to the invention facilitates overcoming this problem in the art. See Figs. 3-6 of the specification, and the text explaining the results depicted in Figs. 3-6 at page 7, line 7 to page 9, line 26. Therefore, the increased etch rate at the periphery of the wafer can be suppressed, according to the invention as recited in claims 9 and 10, with a gas supply rate which is *higher* than that conventionally used, which provides a flow diverging position that is moved *inward* with respect to a conventional flow diverging position, so that the flow diverging position is internal to the outer periphery of the object being etched. This improves the uniformity of the etch rate over the surface of the object being treated. See Appellants' specification at page 9, line 27 through page 10, line 10. This advantage is neither disclosed nor fairly suggested by van Os et al.

Contrary to the invention according to claims 9 and 10, in which a higher flow rate produces a flow diverging position that is internal to an outer periphery of the object being treated, van Os et al. neither disclose nor fairly suggest that the flow rate of the gas might have any effect whatsoever on a flow diverging position. Indeed, van Os et al. make no mention whatever of a flow diverging position, nor how such a position might be obtained or manipulated, nor what might be the result.

Rather than teaching that the flow rate may be set to achieve an advantageous flow diverging position relative to the object being treated, Van Os et al. instead teach only that the gas used be provided from two separate gas manifolds. It can be seen from Fig. 6, cited by the Examiner, that van Os et al. teach both a first gas manifold 15, and a second gas manifold 17, provided at different positions above the object to be processed 24. The flow lines depicted are produced presumably as a result of the combination of the gas flows from the first and second injection manifolds 15 and 17. In the claimed invention, in contrast, it is the flow rate of a flow of gas relative to the object being treated that determines the flow divergent position relative to the object being treated. It is therefore respectfully submitted that van Os et al. do not depict in Fig. 6, nor do they describe in the accompanying text, a flow diverging position. Appellants respectfully note that the Examiner has *not* given any indication in the Office Action where in Van Os et al. the asserted flow diverging position might be. Nor does van Os et al. indicate such a position. Indeed, only the Appellant's specification teaches such a position. Nor do van Os et al. describe how such a flow diverging position might be obtained, nor how it might be advantageously manipulated. Appellants therefore respectfully submit that van Os et al. is entirely silent concerning a flow diverging position.

3. The Motivation cited by the Examiner has been Improperly Derived from the Appellants' Own Specification

The Examiner, in rejecting claims 9 and 10, asserted that one skilled in the art would have found it obvious to modify Collins et al. and Swejkowski et al., by providing a flow rate of etchant to produce a flow diverging position with respect to the outer periphery of the wafer, as assertedly taught in van Os et al., in order to achieve a uniform concentration of etchant, and to promote uniform etching across the wafer. Appellants respectfully submit that the cited motivation could only be derived from the Appellant's own specification, and that the rejection is therefore improper.

Appellants respectfully submit that only the present specification teaches or fairly suggests providing a flow rate of etchant to produce a flow diverging position. The references cited in support of such motivation have already been distinguished on the basis that they lack any such teaching. Similarly, only the Appellants' specification teaches or suggests producing a flow diverging position that is internal to an outer periphery of an object being etched in order to even further facilitate the providing of a uniform concentration of etchant and uniform etching across the wafer. Appellants have already demonstrated as well that the cited references neither teach nor suggest that the flow rate might be chosen to obtain an advantageous flow diverging position, and that this might in turn achieve a uniform concentration of etchant and promote uniform etching across the wafer. Appellants therefore respectfully submit that the Appellants' own specification has been used as motivation, and that such use of the Appellants' specification is improper.

3. Conclusion Regarding the Obviousness Rejection of Claims 9 and 10

Appellants respectfully submit that nothing in van Os et al. discloses or suggests that a flow diverging position be obtained, nor that such a position be located internal to an outer periphery of the object being etched, as recited in Appellants' claims 9 and 10. Appellants respectfully submit further that nothing in the other cited references discloses or suggests this feature of Appellants' claims. Appellants therefore respectfully submit that claims 9 and 10 are not rendered *prima facie* obvious by the combination of Collins et al, Szwejkowski et al. , and van Os et al. Reversal of this rejection is therefore earnestly solicited.

IX. CONCLUSION

As described above, the references relied upon in the Final Office Action are not properly combinable to reject claims 1-14 in this application. The Examiner has not carried his burden of proving that these claims are unpatentable, and therefore, the final rejection of claims 1-14 in this application constitutes reversible error. Reversal of this final rejection is earnestly solicited.

Respectfully submitted,

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X. APPENDIX A

Pursuant to 37 C.F.R. § 1.192(c)(9), this Appendix contains a clean copy of claims 1-14, the claims involved in this appeal.

1. (Original) An etching method comprising:

an etching gas supply step of supplying an etching gas through a gas supply system into a plasma producing chamber;

a plasma producing step of producing radicals in the plasma producing chamber by converting the etching gas into a plasma by applying radio frequency power to the etching gas; and

an etching step of etching an object to be processed in a reaction chamber, which is connected to the plasma producing chamber and is evacuated, by the radicals flowing from the plasma producing chamber into the reaction chamber;

wherein the etching gas is supplied through the gas supply system at an etching gas supply rate of 8.4 sccm or above for a substantial volume of one liter of the reaction chamber.

2. (Original) The etching method according to claim 1, wherein the plasma producing step converts the etching gas into a plasma by inductive coupling using an induction coil.

3. (Original) The etching method according to claim 1, wherein the etching step uses chlorine gas as the etching gas and etches a polysilicon film formed on the object to be processed.

4. (Original) The etching method according to claim 1, wherein the etching gas supply rate is 8.4 sccm to 16.9 sccm for a substantial volume of one liter of the reaction chamber.

5. (Original) The etching method according to claim 2, wherein the etching gas supply rate is 8.4 sccm to 16.9 sccm for a substantial volume of one liter of the reaction chamber.

6. (Original) The etching method according to claim 3, wherein the etching gas supply rate is 8.4 sccm to 16.9 sccm for a substantial volume of one liter of the reaction chamber.

7. (Amended) The etching method according to claim 1, wherein a flow of etchant is provided at a flow rate which produces a flow diverging position with respect to an outer periphery of an object being etched that is substantially at or internal to the outer periphery of the object being etched.

8. (Amended) The etching method according to claim 2, wherein a flow of etchant is provided at a flow rate which produces a flow diverging position with respect to an outer periphery of an object being etched that is substantially at or internal to the outer periphery of the object being etched.

9. (Amended) The etching method according to claim 3, wherein a flow of etchant is provided at a flow rate which produces a flow diverging position that is internal to an outer periphery of an object being etched.

10. (Amended) The etching method according to claim 4, wherein a flow of etchant is provided at a flow rate which produces a flow diverging position that is internal to an outer periphery of an object being etched.

11. (Original) The etching method according to claim 1 wherein the process pressure is about 5 to about 10 mTorr.

12. (Original) The etching method according to claim 11 wherein the process pressure is 5 mTorr.

13. (Original) The etching method according to claim 4 wherein the process pressure is about 5 to about 10 mTorr.

14. (Original) The etching method according to claim 7 wherein the process pressure is about 5 to about 10 mTorr.